EFFECTIVENESS OF POSTERIOR DECOMPRESSION AND SHORT SEGMENT INSTRUMENTED FUSION IN THORACOLUMBAR FRACTURES WITH PARAPLEGIA / PARAPERESIS - A PROSPECTIVE STUDY

Dissertation submitted for

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Thanjavur medical college and Hospital,

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CERTIFICATE

This is to certify that **DR.K.SENTHILKUMAR,** postgraduate (2009-2011) in the Department of Orthopaedics and Traumatology, Thanjavur Medical College and Hospital, Thanjavur, has done this dissertation on **EFFECTIVENESS OF POSTERIOR DECOMPRESSION AND SHORT SEGMENT INSTRUMENTED [PEDICLE SCREW] FUSION IN THORACOLUMBAR FRACTURES - A PROSPECTIVE STUDY** under my guidance and supervision in partial fulfillment of the regulation laid down by the TamilNadu DR.M.G.R. Medical University, Chennai for M.S. (Orthopaedics) degree examination to be held on April 2011.

Prof. Dr. M. Gulam Mohideen M.S. Ortho., D. Ortho
Professor and Head ,
Department of Orthopaedics and Traumatology,
Thanjavur Medical College and Hospital,
Thanjavur.

Prof. Dr. P. Ravi Shankar M.D. DHA.
Dean,
Thanjavur Medical College and Hospital,
Thanjavur.

DECLARATION

I, solemnly declare that this dissertation **EFFECTIVENESS OF POSTERIOR DECOMPRESSION AND SHORT SEGMENT INSTRUMENTED [PEDICLE SCREW] FUSION IN THORACOLUMBAR FRACTURES -- A Prospective Study,** is a bonafide work done by me, at Government Thanjavur Medical College and Hospital between 2009- 2011, under the guidance and supervision of **Prof. Dr. M. Gulam Mohideen, M.S. (Ortho), D. Ortho.,** Professor and Head of the Department of Orthopaedic surgery.

This dissertation is submitted to Tamilnadu Dr. M. G. R. Medical University, towards partial fulfillment of regulation for the award of M. S. Degree (Branch-II) on Orthopaedic Surgery.

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CONTENTS

INTRODUCTION

Spinal injuries in general are devastating. 90% percent of these injuries involve the thoracolumbar region. Thoracolumbar fractures occur from all forms of trauma including fall from height, road traffic accidents and crush injuries[1]. They result from vertical compression to the slightly flexed spine, a rotational or shear component or some extension force can cause a different fracture pattern. Twenty percent of them are associated with neurological deficits, a significant cause of morbidity and mortality. The common mode of spine injury is a fall from height in our population or a road accident. These are either a worker climbing a coconut tree or a painter standing on scaffolding. Most of them involve patients in the young, active age group. This causes financial burden for the family in particular and the country in general. In the past few decades there have been advancements in diagnostic imaging techniques, more stable fixation devices and intra-operative monitoring. There has also been enough work done on the use of steroids to reduce the secondary injury to the neural elements. Despite these advancements, managing these fractures still pose a challenge to orthopaedic surgeons. Hence any research in this regard will be of use to those who treat these unfortunate people. Every year around 70 to 80 cases of dorsolumbar spine injuries are getting admitted in the Orthopaedic department of Thanjavur Medical College Hospital, Thanjavur which provides an ideal setup for any research in this field.

A Short segment posterior instrumentation with Pedicle screw system in spinal injuries achieves a reasonable stability since the pedicle screw and rod system provides a three column fixation in stabilizing the injured spinal column incorporating fewer motion segment in the fusion[2, 3, 4].

Surgical decompression and posterior instrumented fusion in spinal injuries enables the patient to become ambulant without much pain and gives a fair chance of neurological recovery when the compressed neural elements are released [5]. It also increases of the longevity of the patient and decreases the morbidity due to prolonged recumbency in case of complete cord lesions [6]. Moreover operative management helps in executing better nursing care to paraplegics otherwise whose quality of life will decline.

AIM

To evaluate the neurological recovery of unstable thoracolumbar fractures treated by decompression, short segment posterior stabilization with pedicle screw and fusion.

REVIEW OF LITERATURE

The Egyptians were the first to diagnose and treat the spinal injuries -- 2500 BC to 1900 BC. The treatment of spinal fractures was described as early as 1500 years before Christ in the writings of Smith papyrus [7].

Hippocrates distinguished spinal fractures with and without neurological deficit. Spinal fractures without paralysis were treated by distraction, manual reduction, and rest in supine position. Special tables were designed and used for these treatments by Hippocrates and Oribasius [8].

In the seventeenth century, Paulus of Aegina was the first clinician who advocated laminectomy for spinal injuries [9,10].

Later Malgaigne in 1847 and Bohler in 1932 tried indirect manipulative anatomical reduction by longitudinal traction and hyperlordosis, immobilisation in a plaster jacket, followed by intensive muscle training. A French surgeon, Chipault in 1894 published the first textbook on spinal surgery. In 1856, he brought out a specialist yearbook “travaux de neurology chirugicale” which became the first neurosurgical journal in the world. In 1904, he published the manual “de orthopaedic vertebraele” , which primarily dealt with the orthopaedic treatment of spinal disorders .

In the early years of the 20th century, Albee popularized bone grafting in spinal surgery. Bauer investigated the preservation and storage of canine allografts in 1910. In the 1930s, Watson Jones described spinal fractures as due to pure flexion violence and treated them with hyperextension casts. In 1930, vitallium, an alloy of chromium, molybdenum, tungsten, and cobalt, was introduced for internal fixation. Ludwig Guttman from Britain, developed the concept of spinal cord rehabilitation in 1940s. He obtained reduction of spine fractures using traction and postural reduction techniques. Rogers described the interspinous wiring technique in 1940s. In 1945, Cloward introduced the technique of posterior lumbar interbody fusion. In 1949, Nicoll reported on 166 thoracolumbar fractures in coal miners and classified these injuries as anterior wedge fractures, lateral wedge fractures, fracture dislocations, and neural arch fractures[11].

Later, Holdsworth introduced the first modern classification, which was based on the 2-column theory of spinal column stability[12]. He divided the injuries into stable versus unstable fractures using an anatomical classification. In his view, the major determinant of stability was the integrity of the posterior ligamentous complex [13].

Kelly and Whitesides developed a two-column concept of spinal stability [14]. They described the anterior column consisting of the vertebral body, disc, anterior longitudinal ligament and posterior longitudinal ligament.

The posterior column, was formed by the posterior neural arch, facet joints, and posterior ligamentous complex.

This classification had a major impact on the understanding of thoracolumbar injuries. In the 1970s, in Mexico, Luque introduced the sublaminar wiring technique, which was combined with the use of rods. In 1979 Harrington introduced the distraction rod fixation system for the treatment of scoliosis, was also found to be useful to reduce and stabilize spine fractures. In the 1980s, Denis proposed the 3-column theory of spinal instability which was widely accepted because of its simplicity and the anatomical description [15].

In 1987 Dick introduced the "fixateur interne", which uses 5mm Schanz pins linked to 7mm threaded rods [16]. The Schanz pins are placed into the pedicles of the vertebrae above and below the injured level. Cotrel and Dubousset in France developed a system consisting of rods, multiple hooks, and screws.

Arthur Steffe developed Steffe plate and screws. The Hartshill rectangle is a modification of the Luque system. It is a rectangle made up of stainless steel with a bend at its ends that allows the lamina to fit in and secured by stainless wires.

The techniques of posterior instrumentation for thoracolumbar fractures uses simple rod-hook systems to achieve and maintain fracture reduction. Indirect spinal canal decompression was achieved by the development of tension in the posterior longitudinal ligament, which reduces the retropulsed bony fragments by process called ligamentotaxis.

Crutcher et al found that posterior distraction by instrumentation reduces canal compromise by 50% of the initial occlusion.

Edwards et al developed rod sleeves centered over the pedicle of the fractured vertebrae pushing the vertebrae forward, thereby reducing the kyphotic deformity. McLain et al used the short segment fixation using Cotrel-Du-bousset (CD) instrumentation. Moss Miami posterior spinal instrumentation is a hybrid system using pedicular screws, rods, laminar hooks and pedicular hooks used for the management of spinal injuries. Anderson et al reported on the complete neurologic recovery in all patients with incomplete impairment who were treated with posterior instrumentation.

Anterior decompression has been shown to increase the axoplasmic flow, decreases the ischemia and leads to improvement in neurologic function. Anterior instrumentation has been developed by Kaneda [17]. He used threaded rods that rigidly connect to screws placed transversely across the vertebral body.

Roy-Camille in France developed a modern pedicle screw system [18]. These systems replaced the Harrington distraction rod and the Luque rod constructs in the treatment of thoracolumbar spine injuries.

Conservative treatment remained the golden standard for a long time since there was no knowledge about implants were today. It was only in the late 1970's improvements in radio diagnostic tools, safer anaesthetic techniques, modern intensive care facilities and reliable implants paved the way for the development of newer surgical techniques.

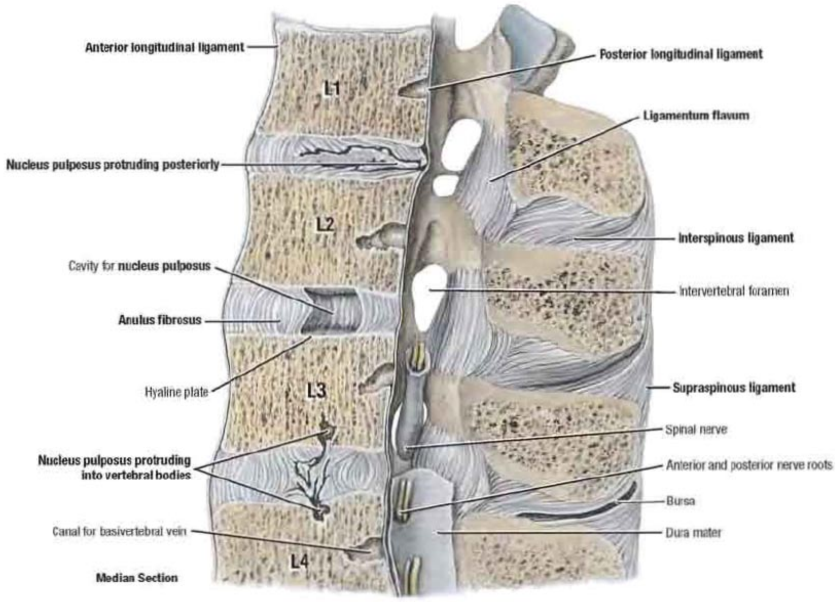
The current method of managing the unstable dorsolumbar fractures is with the pedicle screw and rod system which provides three column fixation of injured vertebral column. Cases with severe loss of anterior body height will need bone graft augmentation through anterior approach. The anterior approach is associated with morbidity of exposure and blood loss, but has the advantage of stabilizing the injured vertebra with bone graft and instrumentation, there by restoring the anterior column support which provides stability and prevents collapse. The posterior approach is relatively easier to approach for stabilizing the fractured spine. It avoids the excessive morbidity of anterior exposure, with shorter operating time and decreased blood loss during surgery with the functional outcome similar to anterior surgery. The short segment posterior instrumentation with pedicle screws and posterolateral fusion achieves good stability as it incorporates fewer motion segments than long posterior fixations.

ANATOMY

The vertebral column comprises of vertebra and discs. They are stabilized with ligaments and paraspinal muscles. There are 33 vertebrae including 7 cervical, 12 thoracic, 5 lumbar, 5 sacral, and 4 coccygeal vertebra of which there are 24 mobile segments[19].

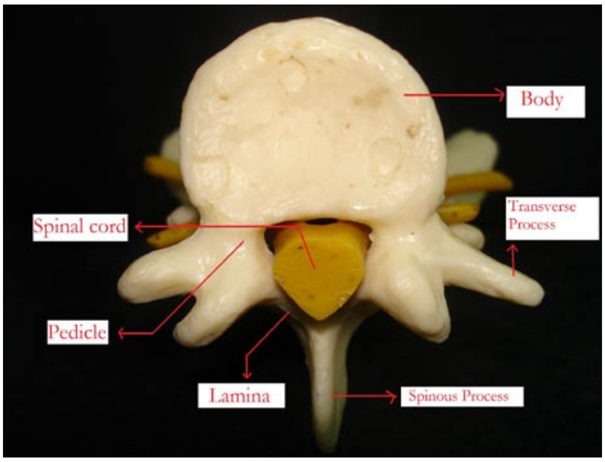
A vertebra consists of a body and a neural arch. The neural arch is composed of two pedicles and two laminae which unites to form the spinous process. It consists of two transverse process laterally and superior and inferior articular facet joints which allows the movement of spine. The bony vertebral coloumn protects the spinal cord. Sandwiched between the two vertebral bodies is the inter vertebral disc containing an outer layer of annulus fibrosis and an inner layer of nucleus pulposus [19].

The adjacent vertebra are connected by facet joints. They are synovial joints covered by an articular cartilage lined by synovial membrane. The whole vertebral coloumn is bridged by ligaments viz anterior longitudinal ligament, posterior longitudinal ligament, ligamentum flavum, supraspinous and interspinous ligaments.



Pedicle Anatomy

The pedicle is the strongest part of the vertebra with strong shell of cortical bone and a core of cancellous bone bridging the body and the posterior spinal elements. The size and angulation of pedicles vary. In general the width of the pedicle is narrower than its height. In the thoracic region the pedicle is widest at D11 and in the lumbar region, the largest pedicle is at L5[20].



The vertical diameter (Height) of the pedicle increases from 7mm to 15mm from D3 to L5 and the horizontal diameter (Width) of the pedicle increases from 7mm to 16mm from D3 to L5. The direction of the pedicle is almost sagittal from D4 to L4. The angulation is about 10 degrees at thoracolumbar junction and at L5 it is about 30 degrees. The cauda equina is very close to the pedicle on the medial side below L1.

Vascular supply of Spinal Column

The thoracolumbar spine receives its blood supply from posterior intercostal and lumbar arteries as inter segmental arteries. The veins form a plexus along the entire vertebral column, both internal and external devoid of valves. The external vertebral veins are anterior and posterior. They receive tributaries from vertebral bodies and anastomose with the internal plexus of veins. The internal plexus are four in number, two anterior and two posterior, drain the vertebral bodies and spinal cord. The basivertebral veins drain the posterior foramina of the vertebral bodies. The intervertebral veins drains mainly the spinal cord and ends in the vertebral venous plexus.

Lymphatic Drainage

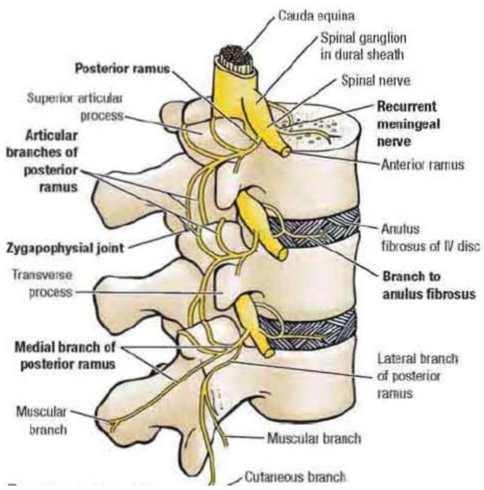
The lymphatics from thoracic region drain into intercostal nodes and the lumbar coloumn drains into para aortic and retro aortic nodes.

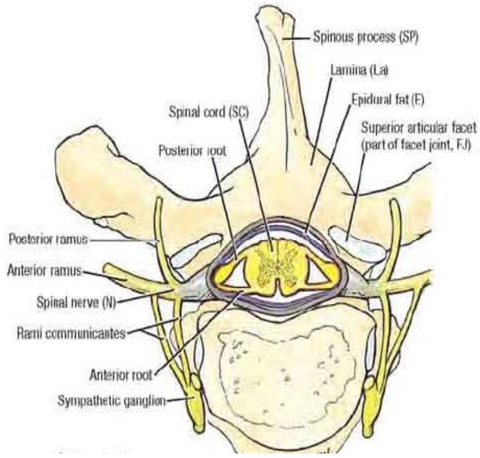
Innervation

The vertebral column is innervated by spinal nerves. The sympathetic system supplies via the grey rami communicantes. The spinal nerve supplies the facet joints and the periosteum of the posterior bony elements

NEUROANATOMY

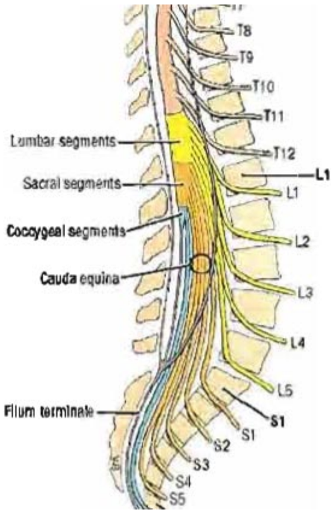
The spinal cord extends from foramen magnum to lower border of L1. It is oval in shape. It is enclosed by duramater, arachnoid mater and piamater. Between dura and piamater is the sub aracnnoid space which contains cerebrospinal fluid. It terminates in conus medullaris from where filum terminale descends downwards. It consists of cortical white mater and an inner grey mater. Roots arising from the anterolateral sulcus form the ventral root and those arising from the posterolateral sulcus forms the dorsal root which terminates in a ganglion before joining with the ventral root to form a spinal nerve. There are 31 pairs of spinal nerve including 8 Cervical, 12 Thoracic, 5 Lumbar, 5 Sacral and 1 Coccygeal. The Spinal nerves below L1 exit through their corresponding neural foramina as Cauda equina.





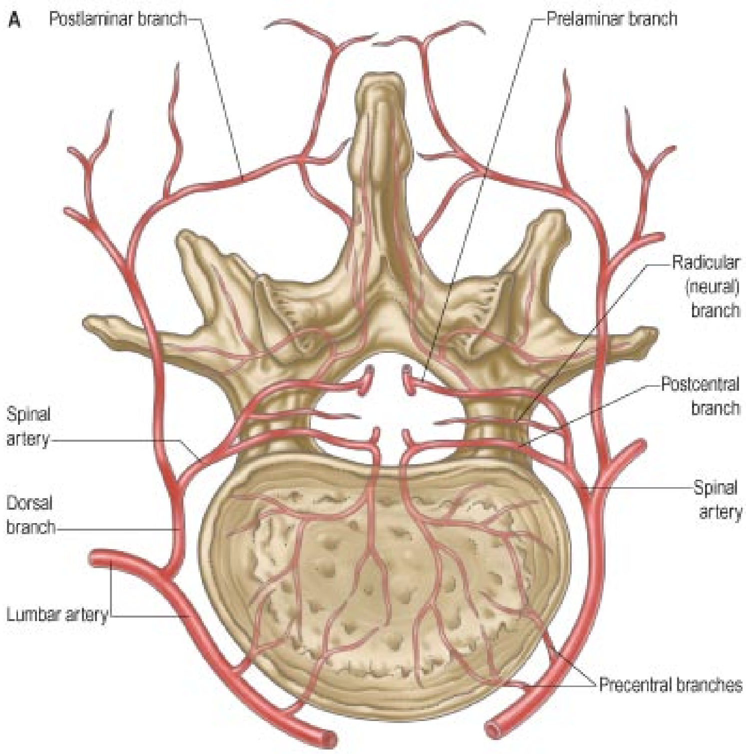
VERTEBRAL LEVELS OF SPINAL CORD SEGMENTS

Bony vertebral Level	**Spinal Segment level**
1. Cervical	One level is added
2. Thoracic D1 –D6	Two levels are added
3. Thoracic D7 – D9	Three levels are added
4. Thoracic D10	L1 –L2
5. Thoracic D11	L3 –L4
6. Thoracic D12	L5
7. Lumbar L1	Sacral segments

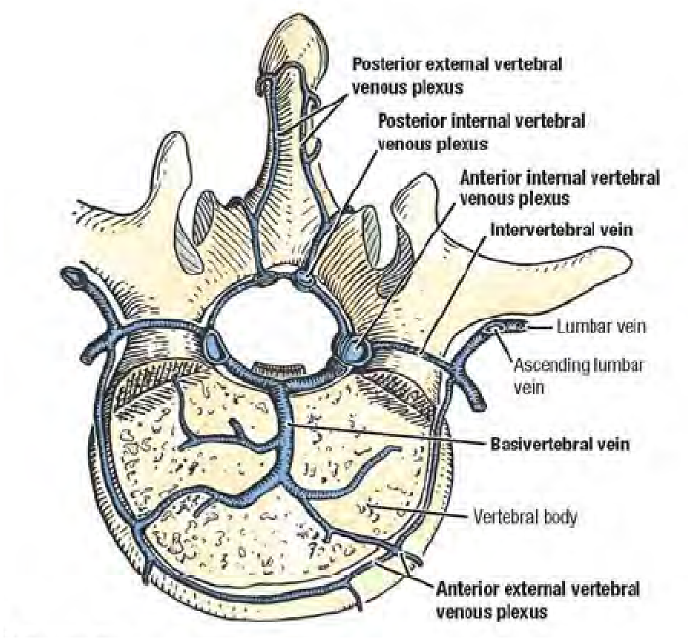


VASCULAR SUPPLY OF SPINAL CORD

The spinal cord is supplied by both longitudinal and segmental vessels. The longitudinal vessel include one anterior spinal and two posterior spinal arteries. The anterior spinal artery arises from vertebral artery. The posterior spinal artery arises either from the ipsilateral vertebral artery or from the posterior inferior cerebellar artery. The segmental arteries arise from the deep cervical, intercostal and lumbar arteries. They form the pial plexus which supplies the cord. Segmental medullary feeder arteries also supply the cord. There are 2 to 17 anterior medullary feeder arteries and 6 to 25 posterior medullary feeder arteries. The largest anterior medullary feeder artery is the Artery of Adamkiewicz [21]. It is located on the left side at the level of T9 – T11 arising from the lower posterior intercostals arteries. The anterior spinal artery supplies the anterior two thirds of the cord. The posterior one third of the cord is supplied by the branch from the posterior spinal artery and the pial plexus. The intraspinal and extraspinal structure are supplied by a pair of segmental arteries at each vertebral level. In the cervical segments it arises from the vertebral arteries, costocervical and thyrocervical trunk, In the thoracic and lumbar segments it arises from the aorta. The sacral segments are supplied by lateral sacral, illiolumbar middle sacral arteries. The segmental arteries divide into various branches at the intervertebral foramen forming the distribution points. The blood supply to the thoracic cord between T4 – T9 is poor.



Venous drainage of the spinal cord is highly variable. There are two sets of veins: veins of the spinal cord and veins that fall within the plexiform network of Batson. The veins of the spinal cord drain into the plexus of Batson. The Batson plexus is a large and complex venous channel extending from the base of the skull to the coccyx. It communicates directly with the superior and inferior vena cava system and the azygos system. There are three components of the Batson plexus of veins which includes the extradural vertebral venous plexus, the extravertebral venous plexus and the veins of the bony structures of the spinal column. They communicate directly with the venous system draining the head, chest and abdomen which allows the metastatic spread of neoplastic material or infectious disease from the pelvis to the vertebral column [22].



CLINICAL ANATOMY

The vertebral column consists of five regions viz ., cervical , thoracic , lumbar, sacral and coccygeal parts .

Region	No of Vertebra
Cervical	C1 → C7
Thoracic ,	T1 → T12
Lumbar	L1 → L5
Sacral	S1 → S5
Coccygeal	C1 → C4

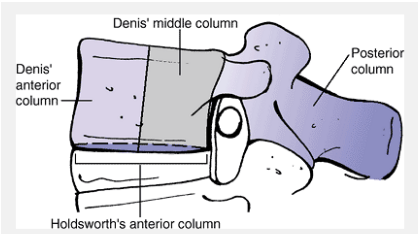
BIOMECHANICS OF THORACOLUMBAR SPINE

The thoracolumbar junction represents a transition zone between the rigid thoracic spine and the flexible lumbar spine [23]. The thoracic musculature, rib cage and facet joints contribute to a stiff thoracic spine which allows rotation only. There is also a change in sagittal alignment between the kyphotic thoracic segment and a lordotic lumbar segment. There is approximately 4 degrees of flexion-extension at each intervertebral segment upto T1 and T6, and a high degree of range of flexion to about 12 degrees at the thoracolumbar junction. The lateral flexion allowed in thoracic segment is about 8 degrees whereas in the lumbar spine it is about 2 degrees [24]. This is due to the sagittal orientation of facet joints in the lumbar spine.

Pathomechanics of injury

Disruption of the costovertebral joints results in substantial increases in intervertebral motion within the thoracic spine [25]. The forces acting in spinal trauma include axial loading, flexion, extension, shear, and axial rotation. The damage occurs as a result of a combination of these forces. Pure axial loads or compressive forces result in end plate fractures, anterior wedge compression fractures, and burst fractures. Flexion forces with center of rotation occurring near the posterior longitudinal ligament, results in a compressive load applied to the anterior vertebral body and a corresponding distraction force within the posterior elements. When a sagittal rotation centers to a point in front of the spine, primary distraction forces act on both the anterior and posterior elements. Extension-type injuries produce tensile forces in the anterior spine with compressive or tensile forces applied to the posterior elements. Pure axial load with minimal extension is the primary mechanism leading to burst fractures, with widening of pedicles and retropulsion of fragments [26].

Denis Three column Theory



Denis developed a three column theory for thoracolumbar injuries [27]. He divided the spinal column into three parts. The anterior column consists of anterior longitudinal ligament, anterior half of the vertebral bodies and anterior half of the annulus with its nucleus pulposis. The middle column consists of posterior half of the vertebral bodies, posterior half of the annulus with its nucleus pulposis and posterior longitudinal ligament. The posterior column consists of neural arch, ligamentum flavum, facet joints, interspinous and supraspinous ligaments. The movements occurring at dorsolumbar spine are rotation at dorsal and flexion, extension and lateral bending at lumbar regions. The movements diminish with age. The local vertebral alignment at the level of injury and the magnitude of impact force determine the pattern of injury. Two adjacent vertebrae and the intervening soft tissue between them form a motion segment. If a motion segment has one anterior and one posterior elements (or) all the posterior and one anterior element intact, then it will remain stable under normal physiological loads.

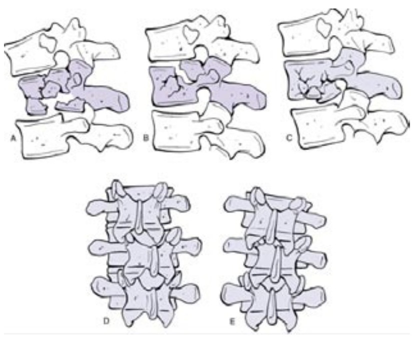
CLASSIFICATION OF THORACOLUMBAR FRACTURES

McAffe Classification [28]

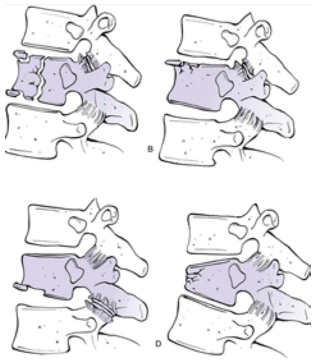
1. Wedge compression fracture
2. Stable burst fracture
3. Unstable burst fracture
4. Chance fracture
5. Flexion distraction injuries
6. Translational injuries

Denis classification

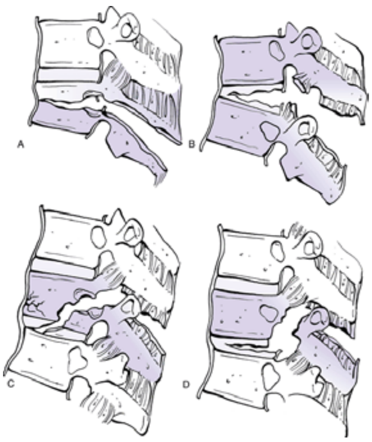
1. Burst fracture



2. Wedge compression fracture



3. Fracture Dislocation

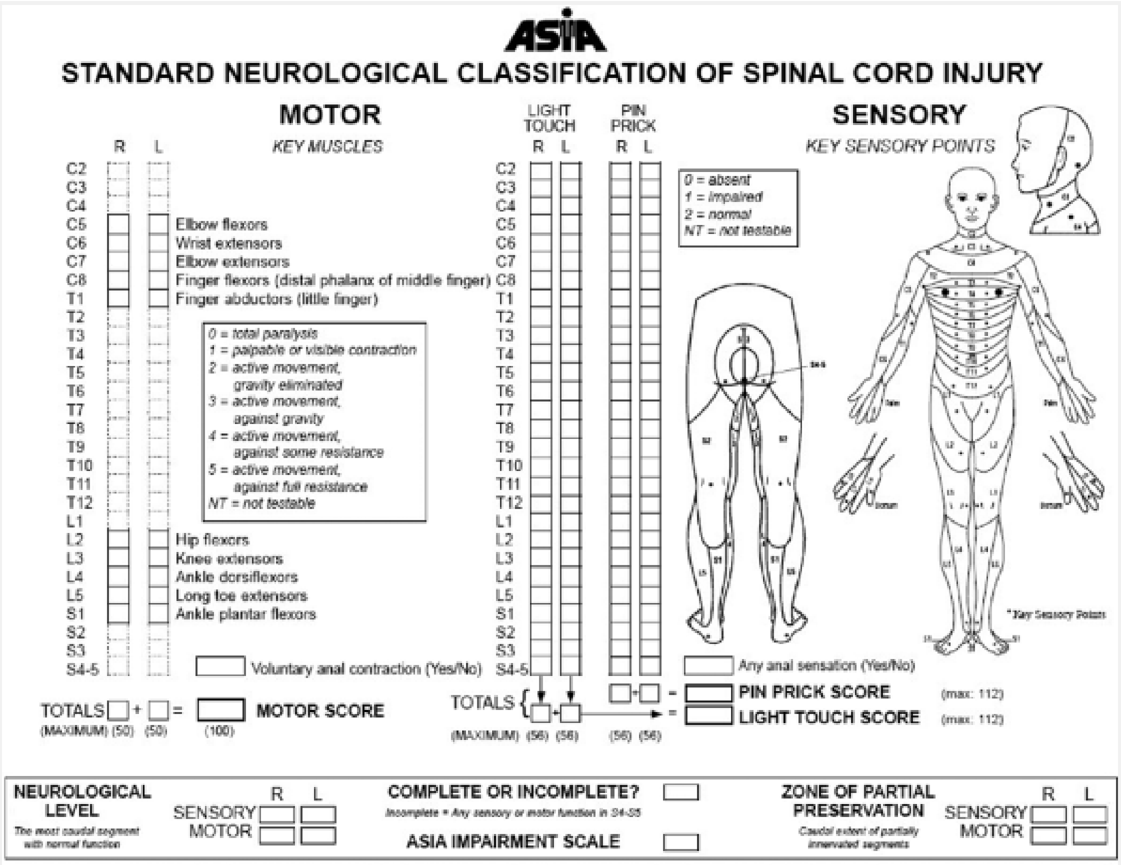


4. Flexion Distraction Injuries

CLINICAL EVALUATION

Any patient suspected of spinal trauma should be received in the trauma ward for assessing the airway, breathing and circulation. They are resuscitated with intravenous fluids, oxygen. The neck should be immobilized with cervical collar. The level of consciousness and neurological status should be assessed to rule out the possibility of head injury. Chest and abdomen should be looked for ecchymoses and lacerations to rule out pulmonary and visceral injuries [29]. The bladder should be catheterized to monitor the urine output. Then the spine is examined along with complete neurological evaluation with minimal shifting of patients. The patients must be rolled on his /her side using a logrolling maneuver for complete examination of spine and to avoid pressure necrosis of skin [30].

The noncontiguous spinal injuries should also be evaluated by examining and eliciting tenderness of whole spine. Other musculoskeletal systems were examined simultaneously to rule out the possibility fracture in extremities. The ASIA has recommended essential elements of neurological assessment in all patients with spinal injury. This includes testing motor power of ten muscles on each side of the body innervated by C5 to T1 and L2 to S1with pin prick assessment at 28 specific sensory dermatomes on each side of the body. The sum of motor and sensory score is calculated and compared with normal. The bulbocavernosus reflex should be tested at the time of injury and also after resolving of spinal shock because it tests the most caudal segment of the spinal cord. Then rectal examination should be carried out to test the resting tone, voluntary contraction and perianal sensation[31].



The ASIA recommends the following ten key muscle groups and their corresponding nerve root levels are tested in a patient with spinal cord injury

LEVEL	MUSCLE GROUP
C5	Elbow flexors – Brachialis and Biceps
C6	Wrist extensors – Extensor carpi radialis longus and brevis
C7	Elbow extensors – Triceps
C8	Finger flexors – Flexor digitorum profundus to middle finger
T1	Small finger abductors – Abductor digit minimi
L2	Hip flexors – Illiopsoas
L3	Knee extensors – Quadriceps
L4	Ankle dorsiflexors – Tibialis anterior
L5	Long toe extensors – Extensor hallucis longus
S1	Ankle plantar flexors – Gastrocnemius and Solleus

The functional consequences of spinal cord injury are described by the severity of neurological dysfunction as complete and incomplete injuries [32].

Complete spinal cord injury

No sensation or voluntary motor function is present caudal to the level of injury in the presence of an intact bulbocavernosus reflex. Reflex returns below the level of the cord injury.

Incomplete spinal cord injury

Some neurologic function persists caudal to the level of injury after the return of the bulbocavernosus reflex. Sacral sparing is represented by perianal sensation, voluntary rectal motor function, and great toe flexor activity. It indicates partial continuity of white matter long tracts with incomplete cord injury, with greater chance of recovery of cord function following resolution of spinal shock. The greater the function distal to the lesion and the faster the recovery, the better the prognosis.

The spinal cord injured patients are graded into five types by ASIA scores and by Frankel’s et al classification [33].

AMERICAN SPINAL INJURY ASSOCIATION SCORE

A	Complete	No motor or sensory function in the lowest sacral segment
B	Incomplete	Sensory function below neurological level & in S4 S5, no motor function below neurological level
C	Incomplete	Motor function is preserved below the neurological level, key muscle groups below neurological level have a grade <3
D	Incomplete	Motor function is preserved below the neurological level, key muscle groups below neurological level have a grade >3
E	Normal	Normal motor and sensory function

FRANKEL CLASSIFICATION

Grade A : Absent motor and sensory function

Grade B : Absent motor function, sensory present

Grade C : Motor function present, but not useful (2 or 3/5), sensory present

Grade D : Motor function present and useful (4/5), sensory present

Grade E : Normal motor (4/5) and sensory function

Patient with thoracolumbar spine injury with associated neurological deficit should be given steroids as per NASICS III study. The dose is 30 mg/kg loading dose of Methyl prednisolone given over 15 minutes, followed by continuous administration of 5.4 mg/kg/hr for 24 hours if they came within 3 hours of injury and for 48 hours if they came between 3 & 8 hrs after injury along with intravenous pantaperazole injection.

SPINAL SHOCK

In spinal cord injury immediate depolarisation of axonal membranes from kinetic energy causes spinal shock, in which there is disruption of all cord function distal to injury, including reflexes [34]. It usually resolves within 48 hrs of injury but rarely it can take many weeks. Hence a second neurological examination should be conducted after 48 hrs to accurately predict muscle recovery. Return of bulbocavernous and anal wink reflex indicates the end of spinal shock. They are further classified into complete and incomplete lesions.

There are different types of spinal cord injury syndromes which refers to the pattern of neurological dysfunction which includes the following [35]

CENTRAL CORD SYNDROME

This is the most common spine injury and it is due to destruction of central area of spinal cord including both grey and white matter. The centrally located arm tracts in the corticospinal tracts are the most severely affected. Sensory sparing is variable. Prognosis for recovery is variable and more than 50 % recover bladder and bowel function / control and become ambulatory. Functional use of hands rarely recovers. It usually results from hyperextension injury in an older person with pre existing osteoarthritis of spine.

ANTERIOR CORD SYNDROME

It is due to damage to the anterior 2/3 of spinal cord and characterised by complete motor and sensory (pain and temperature) loss distal to the level of injury. The posterior column is spared.

POSTERIOR CORD SYNDROME

It involves the dorsal columns of the spinal cord and produces loss of proprioception and vibration sense while preserving other motor and sensory function.

BROWN SEQUARD SYNDROME

The most prognostically favourable incomplete spinal cord injury with more than 90 % of patients recovering bowel or bladder and ambulatory function. It occurs due to Injury to one lateral half of cord and preservation of contralateral half characterized by ipsilateral loss of motor function and proprioception and contralateral loss of pain and temperature.

CONUS MEDULLARIS SYNDROME

It results from injury to the lumbar nerve roots and sacral cord characterized by areflexic bowel, bladder and lower limbs with or without preserved bulbocavernosus and micturition reflexes.

CAUDA EQUINA SYNDROME

It results from injury to the lumbar nerve roots and sacral cord characterized by areflexic bowel, bladder and lower limbs

RADIOLOGICAL EXAMINATION

Spinal injury patients are assessed by radiological methods following clinical evaluation. Systematic radiological evaluation is necessary to avoid missed injuries.

RADIOGRAPHS

The patient's are radiographed in supine position. The x- ray beam and film are positioned in such away to get the desired image without moving the patients to various positions in order to avoid secondary injuries. Accurate interpretation of the anteroposterior and lateral radiographs are essential. The following parameters are evaluated for signs of instability, like interspinous widening, translation of vertebra and vertebral body height loss.

A motion segment is made up of two adjacent vertebrae and the intervening soft tissues. If a motion segment has all the anterior elements with one posterior element intact, or all the posterior elements and one anterior element intact, it will remain stable under normal physiological loads.

White and Panjabi defined instability as the loss of ability of the spine to maintain relationships between vertebrae under physiological loads. The checklist for the diagnosis of clinical instability includes the following in which a score of 5 or more indicates instability.

White and Panjabi Thoraco lumbar Instability Scale

Sl No	Element	Points
1	Anterior element unable to function	2
2	Posrerior element unable to function	2
3	Disruption of Costovertebral articulations	1
4	Sagittal plane displacement (T) > 2.5 mm; (L) > 4.5 mm	2
5	Sagittal plane angulation (T) > 5 deg; (L) > 22 deg	2
6	Spinal cord or Cauda equine damage	2
7	Dangerous load anticipated	1

Instability: Total Points >/= 5

COMPUTED TOMOGRAPHY

In general CT scan is indicated for patients with suspected spinal fractures and dislocation that are not identified on plain radiographs and patients with incomplete visualization of the spinal column. Excellent bony detail of the fracture pattern usually can be obtained with CT scan. It is a very useful tool for evaluating

Wedge compression fracture,

Burst fracture with retropulsed fragment, Fracture dislocations,

Bony chance fracture,

Extent of canal compromise and

Pedicle dimension of uninjured vertebra for preoperative planning

MAGNETIC RESONANCE IMAGING

The MRI is indicated in every spinal cord injured patients to assess the status of the cord, disc and posterior ligamentous complex. It also detects the spinal cord edema and haematoma. It is 90 % sensitive and 100 % specific. Increased cord signals are associated with poor prognosis.

The investigation of choice in spinal cord injuries.

To know the exact status of the cord and cauda equina

To know the intactness of posterior longitudinal ligament

To rule out traumatic disc prolapse

To rule out soft tissue chance fracture

Degree of canal compromise

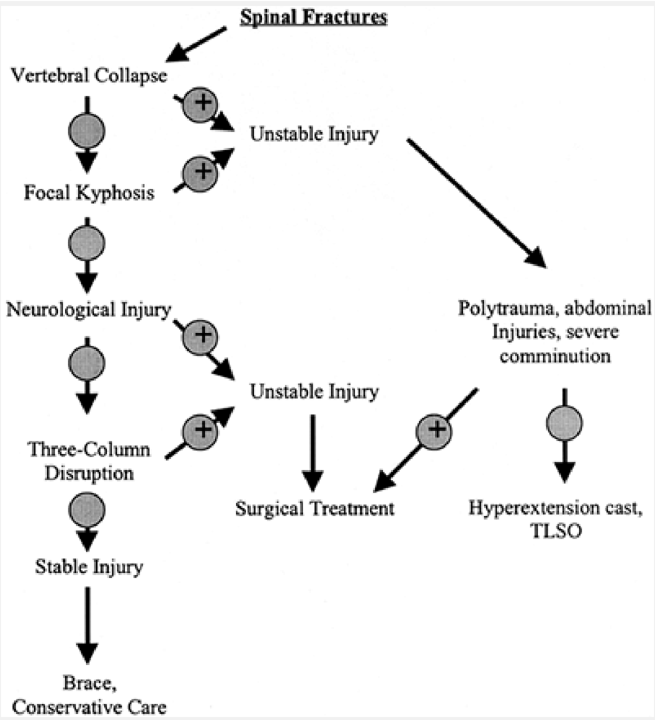
MANAGEMENT

The goals of management in thoracolumbar spinal injuries are to

- Protect against further neural injury,
- Optimize conditions for maximal neurological recovery,

- Maintain or restore spinal alignment,
- Preventing spinal mobility in uninjured segments,
- Obtain a healed and stable spinal column,
- Prevention of morbidity associated with prolonged recumbency and pain reduction,
- Facilitate rehabilitation.

TREATMENT ALGORITHM



NONOPERATIVE TREATMENT

It is indicated for stable thoracolumbar spine injury with no compression of neural elements including stable compression fractures of vertebral bodies, stable burst fractures, undisplaced fractures of lamina, spinous process which are treated with rest for 8 to 12 weeks. Serial X – Rays are obtained weekly for the first 3 weeks and then at 6 weeks, 3 months, 6 months, and one year to look for any instability.

Rarely patients with neurological deficit were also treated by conservative management, they were treated by postural reduction and immobilization on an orthopaedic bed being turned manually[36].

SURGICAL TREATMENT

Indications for surgery

Unstable Thoracolumbar Spine fracture with paraplegia / paraperesis

Wedge compression fracture with 40 % loss of Anterior body height

Burst fracture with paraplegia

Spinal cannal compromise > 50%

Thoracolumbar Injury Severity Score helps to determine whether operative treatment of the thoracolumbar spinal injuries is appropriate for that particular fracture pattern [37].

THORACOLUMBAR INJURY SEVERITY SCORE

Sl NO	Fracture Mechanism	Points
1	Compression #	1
2	Burst #	1
3	Translation / Rotation	3
4	Distraction	4
	Neurological Involvement	
1	Intact	0
2	Nerve root	2
3	Cord, Conus medullaris Incomplete	3
4	Cord, Conus medullaris complete	2
5	Cauda equine	3
	Posterior Ligamentous complex Integrity	
1	Intact	0
2	Injury suspected	2
3	Injured	3

Score ≤3 → Non Operative Treatment

Score 4 → Non Operative / Operative Treatment

Score 5 →Operative Treatment

TIMING OF SURGERY

Early surgery may improve neurological recovery and decrease hospitalization time. Patients are taken up for surgery as soon as they are medically fit for anaesthesia. In the presence of a progressive neurological deficit, emergency decompression is indicated.

SURGICAL TECHNIQUE

POSTERIOR APPROACH

A posterior decompression is often performed in patient with symptomatic neural compression. In general it is indicated most often in posterior long ligament injury as healing is unlikely with external immobilization. Here posterior fusion with instrumentation may be indicated to obtain stability, maintain alignment and to prevent chronic pain or progressive deformity. Pedicle screw system provides rigid fixation and is advantageous when lamina and spinous process are deficient. It avoids the morbidity of anterior exposure in patients who have concomitant pulmonary or abdominal injuries and involves shorter operative time, decreased blood loss and functional outcomes similar to anterior surgery [38, 39, 40]

ANTERIOR APPROACH

Anterior reduction, decompression and stabilization eliminate the risk of extruded disc fragments encroaching on the spinal canal, and provide an effective method of reduction. It is also an easy method of stabilizing a single motion segment. Anterior discectomy, fusion and rigid anterior stabilization can also be done with posterior ligament injury. Anterior internal fixation provides stability often making an additional posterior surgery unnecessary.Anterior Surgery results in greater neurologic improvement than posterior decompression [41.] The main advantage in anterior surgery is the restoration of anterior column support, which provides greater mechanical stability and prevent late collapse in more unstable comminuted burst fractures than posterior instrumentation alone [42,43].

COMBINED APPROACH

The complex pathology that is present with spinal trauma necessitates exposure of both anterior and posterior portions of spine. It can be done in staged procedure or sequentially in one procedure. The advantages of a combined approach includes maximization of canal clearance and immediate circumferential stability. The main drawback of combined surgery is the added morbidity of two separate procedures.

POSTERIOR DECOMPRESSION AND FUSION

The current generation of posterior spinal instrumentation primarily uses pedicle screw fixation. Biomechanically, there appears to be little difference in terms of stability between anterior and posterior fixation since it stabilizes the three columns of the spine.

IMPLANT OPTIONS [44]

Implant options in the management of Thoracolumbar fractures include the following

1. Posterior Instrumentation

Non segmental → Rod and hook system (Harrington rod)

Hybrid system → (Luque rod, Harrington rod with sublaminar wires).

Segmental system → Rod and hook constructs,

Extended pedicle screw constructs,

Short-segment pedicle instrumentation and

Compression instrumentation.

2. Anterior Instrumentation

Anterior plate, screw and rod instrumentation

Anterior struts.

The pedicle screw system includes the monoaxial and polyaxial system and depending on the locking screws available. They are single locking screws and double locking screws.

1. A monoaxial pedicle screw has one axis, which means that its top segment, or arm, forms a continuous, linear, rigid structure with its bottom threaded segment.
2. The polyaxial, or multiaxial pedicle screws are the modern standard when it comes to spinal fusion surgery. They have mobile arms, which can swivel freely of their threaded bottom segments. This helps reduce stress on the spinal column, as bracing rods stretching between two screws can flex and adapt more easily to body movements.

BIOMECHANICS OF PEDICLE SCREWS

Pedicle screw systems provide a high degree of construction stability and afford good fixation to the spine. They provide three column fixation in unstable spinal injuries [45]. Being inserted into the vertebral body, these posterior devices can directly manipulate the intervertebral space. It also allows selective application of distraction, compression, lordosis, rotation, and anterolisthesis or retrolisthesis forces. They are the most important factor that provides torsional stiffness in thoracolumbar spinal constructs. Workers who advocate these implants for the thoracolumbar instability after burst fracture want augmentation with anterior column support to avoid exposing the screws to excessive cantilever loads that might cause bending failure or breakage.

MATERIALS & METHODS

Fifteen patients of unstable thoracolumbar fractures involving D11 to L3 with neurological deficit who were admitted between May 2009 to September 2010, were treated by posterior decompression with short segment posterior instrumentation with pedicle screw system and intertransverse fusion. This prospective study included 10 unstable burst fractures, 3 anterior wedge compression fractures and 2 fracture dislocations. The unstable fracture were defined by clinical and radiological parameters. They include burst fractures with any one of the following criteria, a. neurological deficit, b. more than 50 % axial compression and c. more than 25 % angulation, wedge compression fractures involving middle column with neurological deficit and fracture dislocations with neurological deficit. The study includes 13 males and 2 females. The age group involved in our study ranged between 17 years and 59 years. All the patients were admitted in the emergency ward and resuscitated appropriately. Complete clinical and neurological examination was done. In our study only 3 patients presented to us within 8 hours and they had been given Methylprednisolone as per NACIS III protocol. The level of spine injury was assessed clinically and radiologically.

The spinal injuries were classified based on Denis classification system in our study.

INCLUSION CRITERIA

Unstable burst fracture with neurological deficit,

Fracture dislocation with neurological deficit and

Anterior wedge compression fracture with neurological deficit.

EXCLUSION CRITERIA

1. Fractures without neurological deficit including.

 Stable burst fracture,

 Stable anterior wedge compression fracture and

 Chance fracture,

2. Late presentation with large pressure sores,

3. Elderly with severe osteoporosis and

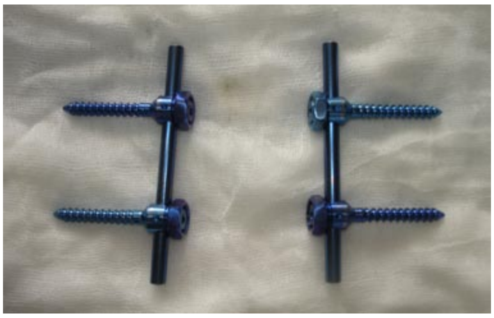
4. Poor anaesthetic risk

The patient's neurological deficit was quantified as per Frankel's et al grading. Out of 15 patients, 7 patients were paraplegics and 8 had paraparesis. According to Frankel's et al grading, 7 patients with grade A, 2 patients with grade B, 5 patients with grade C and 1 patient with grade D. All the patients underwent magnetic resonance imaging to know the status of the cord, integrity of the posterior longitudinal ligament, presence of disc herniations and the degree of canal compromise. All the burst and fracture dislocations patients had CT scan imaging to detect retropulsion of fractured fragments, canal compromise and for assessing pedicle dimensions. Ultrasonogram abdomen was done and visceral injuries were ruled out. These patients underwent posterior decompression with short segment posterior instrumentation and intertransverse fusion.

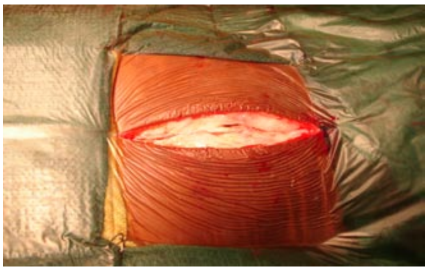
OPERATIVE TECHNIQUES

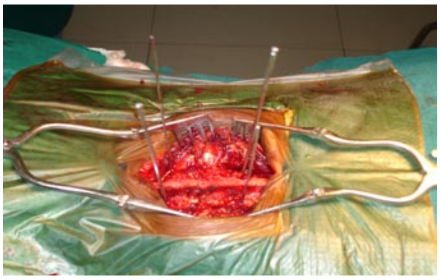
General anesthesia was given by a cuffed endotracheal tube. The patient was placed in prone position in operating table such a way the abdomen is free from pressure. The level of the injured spine as marked by C arm was taken as centre of the incision. The dorsolumbar spine was approached by midline incision and the dorsolumbar fascia was incised in line with skin incision. The spinous processes were identified and the plane between spinous processes and paraspinal muscles laterally was made. The paraspinal muscles were erased sub periosteally and reflected laterally with a self retaining spinal retractor. The pedicles were identified by a point were the middle of the transverse process and the longitudinal axis of the superior facet meet. The pedicle screws were passed under image intensifier control after probing the pedicle and measuring its depth. The commonly used screw size in our study include 5 mm for thoracic pedicles and 6 mm for lumbar pedicles. Then the pedicle screws were bridged with two connecting rods fixed with an inner screw. Decompressive laminectomy was done after fixing the screws to decompress the neural elements. In 4 patients with burst fractures we found the retropulsed fragments compressing the thecal sac was pushed anteriorly into body. Intertransverse fusion was done with bone graft obtained from the decorticated lamina and spinous process to avoid morbidity of the donor site. Wound closed in layers with a negative suction drain after attaining perfect haemostasis.

INSTRUMENTS AND IMPLANTS



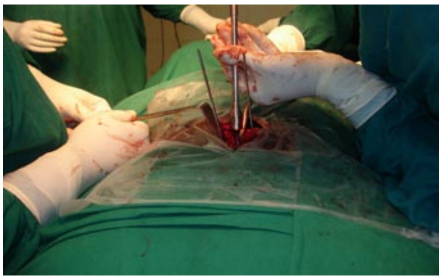
<u>**INTRAOPERATIVE PICTURES**</u>





SKIN INCISION

IDENTIFICATION OF PEDICLES



ENTRY WITH AWL

INSERTION OF SCREWS

PEDICLE SCREWS IN SITU

PEDICLE SCREWS WITH RODS

PEDICLE SCREW CONFIRMATION IN C ARM

POSTOPERATIVE MANAGEMENT

All the patients were turned sideways periodically in the immediate post operative period. Drainage tube was removed at 48 hours. They were allowed to sit after wearing a Taylor's brace with a back support on 5th post operative day. Suture removal was done on 10th day. Active assisted and passive exercises were taught to keep the joints supple. Clean intermittent self catheterization was taught in the post operative period.

FOLLOW UP

All the patients were advised to continue the Taylor's brace for the first 3 months after the surgery. They were followed up every month till 6 months and then every 2 months during the next 6 months.The minimum follow up in our study is 3 months and the maximum follow up is one year and 3 months. During the follow up period the pain and working ability were assessed using Denis pain and work assessment scale and also evaluated clinically and radiologically for the following.

1. Able to sit independently,
2. Walk with support,
3. Walk without support,

4. Bladder control,
5. Fracture consolidation and fusion and
6. Implant status

DENIS PAIN SCALE

P1	No pain
P2	Occasional minimal pain ; no need for medication
P3	Moderate pain, occasionally medications e n interruption of work or activities of daily living
P4	Moderate to severe pain, occasionally absent from work; significant changes in activities of daily living
P5	Constant, severe pain; chronic pain medications

DENIS WORK SCALE

W1	Return to previous employment (heavy labor) or physically demanding activities
W2	Able to return to previous employment (sedentary) or return to heavy labor with restrictions
W3	Unable to return to previous employment but works full time at new job
W4	Unable to return to full time work
W5	No work, completely disabled

Statistical Analysis of data from the results obtained

The data were expressed using descriptive statistics such as mean, standard deviation, frequency, percentage, etc. Comparison of continuous variable between groups, was done using independent sample‘t’ test / ANOVA. Categorical variables were analysed by Chi square test for their significant association. P value < 0. 05 were considered statistically significant. Following observations were made from the statistical data obtained from our study.

OBSERVATION AND RESULTS

In our study we had 13 males (86.66%) and 2 females (13.33%) patients who sustained spinal injuries with neurological deficit and most of them had a fall from height (n=12). The male to female ratio was 6.5**:** 1. The most common mode of injury in our study was fall from height (80 %).

Chart 1 shows the Frequency of male and female in our study

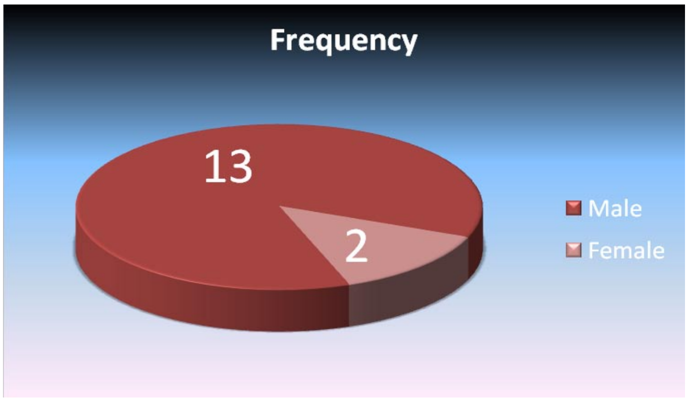
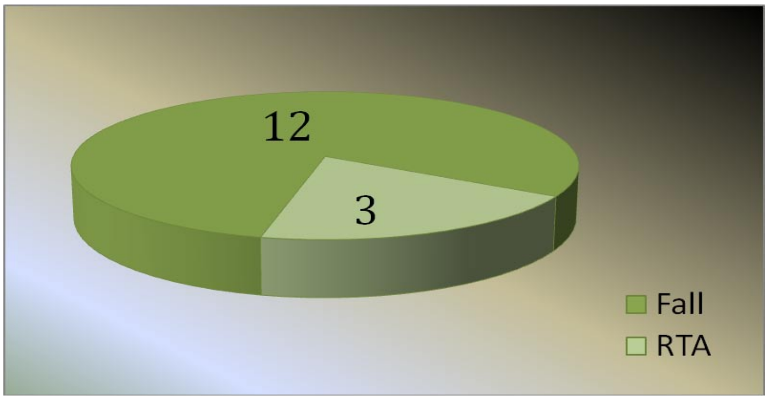


Chart 2 shows the mode of injury, frequency, and the percentage of distribution



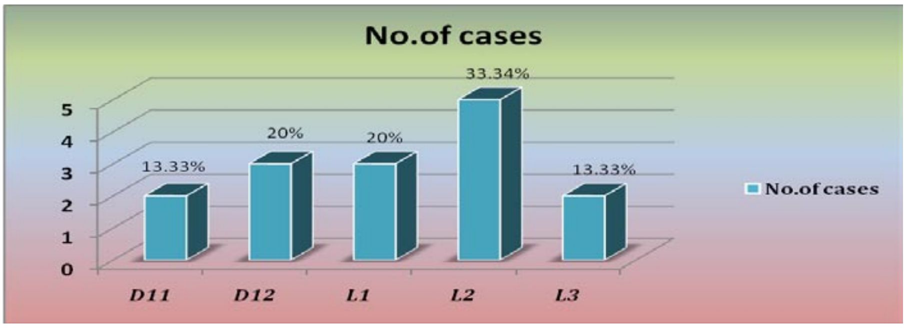
The most common age group who sustained injuries in our study was 21 - 30 years with 6 patients comprising of 40 % of the study population. The minimum age group was 17 years and the maximum age group was 59 years in our study. The mean age 34.33 years.

TABLE 4 shows the age wise distribution of cases

AGE	NO OF CASES	PERCENTAGE
11 –20	2	13.33
21 -- 30	6	40.00
31-- 40	4	26.66
41-- 50	2	13.33
51-- 60	1	6.66
TOTAL	**15**	**100**

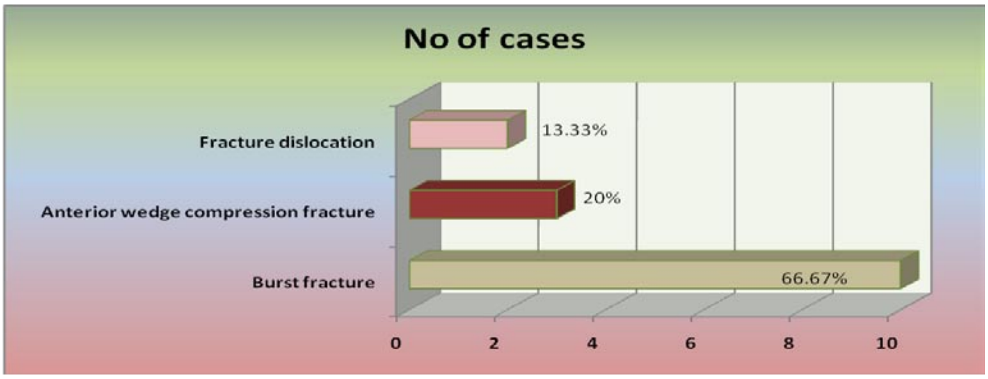
In our study most of the patients did not have steroids as they presented late to our institution (n=12). The most common level of injury in our study was L 2 in 5 cases (33.34%), followed by D12 in 3 cases (20%), L1 in 3 cases (20%), D 11 in 2 cases (13.33%) and L3 in 2 cases (13.33%).

Chart 3 shows the level, number and their percentage of distribution



We had 10 burst fractures (66.66 %), 3 wedge compression fractures (20 %) and 2 fracture dislocations (13.33%) in our study.

Chart 4 shows Type of fracture, number of cases and percentage of distribution



In our study the commonest type of lesion is Frankel grade A constituting 46.66 % of the total number of cases in the study. There was significant association between the PLL [Posterior longitudinal ligament] status and pre operative Frankel grade with PLL [Posterior longitudinal ligament] being disrupted in severe Frankel grades (for e.g. Frankel grade A).

TABLE 2 shows the percentage of the cases in Frankel grade.

TYPE OF LESION (FRANKEL GRADE)	NO OF CASES	PERCENT
A	7	46.66
B	2	13.34
C	4	26.66
D	2	13.34
E	0	0
TOTAL	**15**	**100**

In our study all the cases underwent posterior decompression with posterior stabilization and fusion. All the patients were operated between 8 and 20 days of initial injury. Neurologic function improved by at least one Frankel grade in thirteen (86.66%) of the fifteen patients with neurological deficit. Neurologic function improved by at least one Frankel grade in five patients and two grades in three patients with incomplete neurologic deficits. Neurologic function improved by at least two Frankel grades in four and three grades in one of the seven patients with complete neurologic deficits. Neurologic function remained at the preoperative level in two patients with complete neurologic deficits. One patient who died 3 weeks after surgery (case no 4), other patient had a dural tear (case no 5) repaired intra operatively . These two patients had 0 % improvement postoperatively. In our study 12 cases had bladder involvement, out of which 5 of them had recovered. There was significant association between the pre operative Frankel grading and the bladder involvement (p value of 0.016) with the bladder being involved in severe Frankel grades (for eg Frankel grade A and B). Statistically there was no correlation between bony level and the recovery of the bladder (p value 0. 202).

TABLE 3 shows the preoperative and postoperative neurological status

PRE OP NEUROLOGICAL STATUS	POST OP NEUROLOGICAL STATUS
FRANKEL GRADE A - 7 Cases (46.66%)	A→D (1 Case) A→ C (4 Cases) A→ A (2 Cases)
FRANKEL GRADE B – 2 Cases (13.34 %)	B → D (2 Cases)
FRANKEL GRADE C – 4 Cases (26.66%)	C→ E (1 Case) C→ D (3 Cases)
FRANKEL GRADE D - 2 Cases (13.34%)	D→ E (2 Cases)

The associated injuries in our study population which includes unilateral calcaneal fractures in three patients, closed ulna fracture in one patient, clavicle fractures in two patients and rib fracture without haemo pneumothorax in two patients. All the associated fractures were treated by non operative methods.

In our study Denis pain scale showed that 40% of patients had minimal pain, 40 % of patient had moderate pain and 20 % had moderate to severe pain with significant changes in daily activities, the Denis work assessment scale showed that 33.33 % of patients had unable to return to the previous job but can able to work full time with job modification, 26.67 % of patients cannot able to work full time and 40 % of patients were completely disabled.

Denis pain scale	No of patients
P1	0
P2	6 (40%)
P3	6 (40%)
P4	3 (20%)
P5	0

Denis work scale	No of patients
W1	0
W2	0
W3	5 (33.34%)
W4	4 (26.66%)
W5	6 (40%)

COMPLICATIONS

We had 3 cases of grade I bed sore which were managed by antibiotics, dressings and periodical turning of patients, 3 patients had urinary tract infection managed by appropriate parenteral antibiotics and bladder wash with Povidone iodine and normal saline. We had a case of postoperative superficial wound infection which was settled with regular dressings and antibiotics. Two cases developed paralytic ileus which were managed by intravenous fluids and Ryles tube aspiration. We had a case of dural tear which was repaired Intra operatively and did not have cerebrospinal leak post operatively. These patients were followed and none had a postoperative cerebrospinal leak. We had one death in our study which occurred one month after discharge due to co morbid conditions. We had one case of malplacement of screw in our study which was revised later.

ILLUSTRATED CASE 1

A 30 year old male, had a history of fall from height and suffered Burst fracture of D12. On clinical examination he was in Frankel grade B neurology. The X-ray showed Burst fracture of D12. There was bladder involvement which was recovered. His MRI showed fractured D12 body compressing the cord with disrupted posterior longitudinal ligament. He underwent surgery at 2 weeks of injury with decompression, short segment instrumentation with pedicle screw and rod construct and intertranverse fusion. He had urinary tract infection. Rest of his post operative period was uneventful. At final follow up he was in Frankel grade D. His Dennis pain assessment scale was P2 and work assessment scale was W3.

CASE 1


PRE OPERATIVE X RAY SHOWS BURST # D12

MRI SHOWS BURST # D12
THE COMPRESSING THE CORD


IMMEDIATE POST OPERATIVE PICTURES



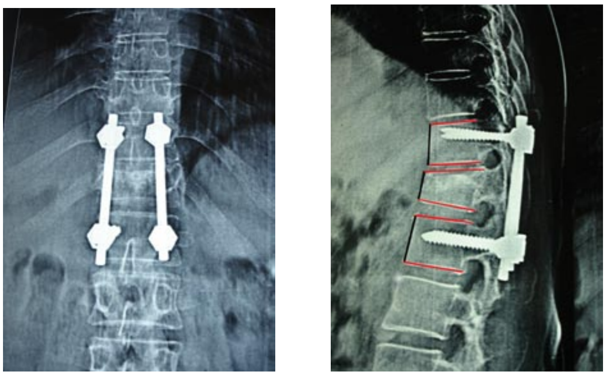
AT 3 MONTHS FOLLOW UP PERIOD

ILLUSTRATED CASE 2

A 35 year old male, had a history of fall from height and suffered Anterior wedge compression fracture of D12. On Clinical examination he was in Frankel grade C neurology. The X ray showed Anterior wedge compression fracture of D 12. There was bladder involvement which was recovered later . His MRI showed disrupted posterior longitudinal ligament, with the fractured D12 body compressing the cord. He underwent surgery on 16th day of injury with decompression, short segment instrumentation with pedicle screw and rod construct and intertranverse fusion. He had superficial wound infection at the surgical site which healed with antibiotics and dressings. Otherwise his post operative period was uneventful. At final follow up period he was in Frankel grade D. His Dennis pain assessment scale was P3 and work assessment scale was W4.

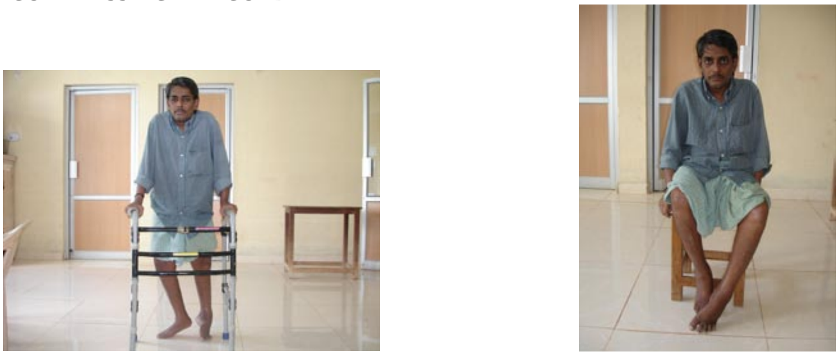
CASE 2

PRE OPERATIVE X RAY SHOWS ANTERIOR WEDGE COMPRESSION # OF D12

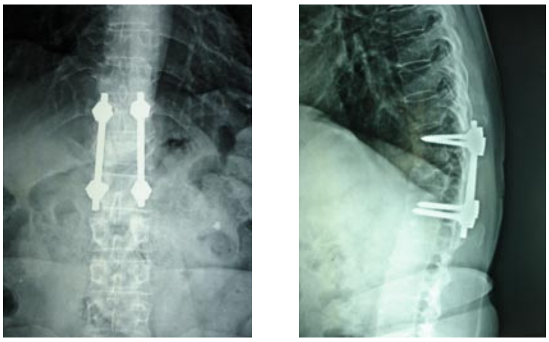


MRI SHOWING WEDGE COMPRESSION #D 12 COMPRESSING THE CORD

IMMEDIATE POST OP



CLINICAL IMPROVEMENT AT 6 MONTHS FOLLOW UP

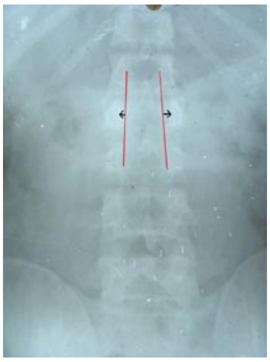


AT 6 MONTHS FOLLOW UP

ILLUSTRATED CASE 3

A 20 year old male had a history of fall from height and suffered Burst fracture of L2.On Clinical examination he was in Frankel grade A neurology. The X ray showed Burst fracture of L2 with widening of pedicles. There was bladder involvement which was not recovered. His MRI showed disrupted posterior longitudinal ligament, compression of cauda equina with the fractured L2 body compressing the thecal sac. He underwent surgery on 19th day of injury with decompression, short segment instrumentation with pedicle screw and rod construct and intertranverse fusion. His post operative period was uneventful except there was a urinary tract infection which was managed with urinary antibiotics. At final follow up he was in Frankel grade D. His Dennis pain assessment scale was P4 and work assessment scale was W4.

CASE 3



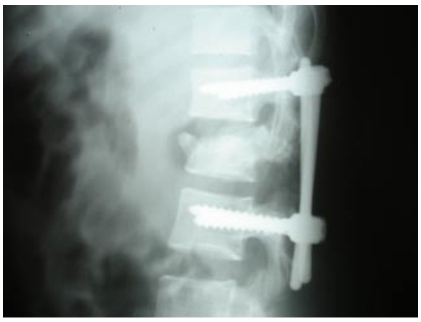
X RAY SHOWS BURST # L2 WITH WIDENED PEDICLE

MRI SHOWS CAUDA EQUINA, PLL NJURY WITH BURST # L2 COMPRESSING THE THECAL SAC

IMMEDIATE POST OP

SURGICAL SCAR

3 MONTHS POST OP - CLINCAL PICTURE



AT 3 MONTHS FOLLOW UP

ILLUSTRATED CASES 4

A 37 year old male had a history of fall from height and suffered Anterior wedge compression fracture of L1. On Clinical examination he was in Frankel grade D neurology. The X ray showed Anterior wedge compression fracture of L1. There was no bladder involvement. His MRI showed fractured L1 body compressing the cord. He underwent surgery on 11th day of injury with decompression, short segment instrumentation with pedicle screw and rod construct and intertranverse fusion. His post operative period was uneventful. At final follow up he was in Frankel grade E. His Dennis pain assessment scale was P2 and work assessment scale was W3.

CASE 4

PRE OPERATIVE XRAY SHOWS ANTERIOR WEDGE COMPRESSION # OF L1

MRI SHOWS L1 # COMPRESSING THE CORD

IMMEDIATE POST OPERATIVE PICTURE

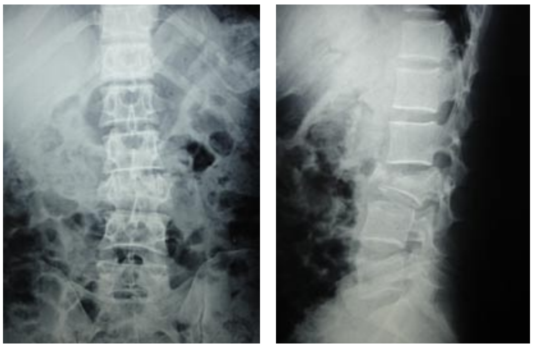
3 MONTHS FOLLOW UP CLINICAL PICTURES

AT 3 MONTHS FOLLOW UP

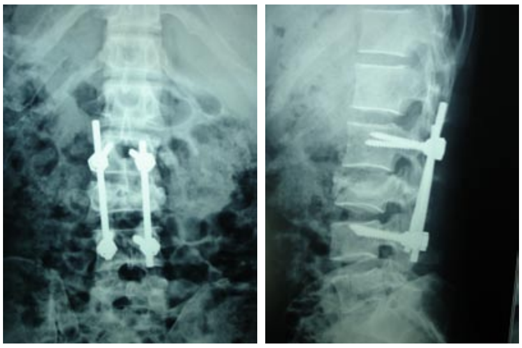
ILLUSTRATED CASES 5

A 50 year old male, had a history of fall from height and suffered Anterior wedge compression fracture of L3. On Clinical examination he was in Frankel grade D neurology. The X ray showed Anterior wedge compression fracture of L3. There was no bladder involvement. He underwent surgery on 8th day of injury with decompression, short segment instrumentation with pedicle screw and rod construct and intertranverse fusion. His post operative period was uneventful. At final follow up he was in Frankel grade E. His Dennis pain assessment scale was P2 and work assessment scale was W3.

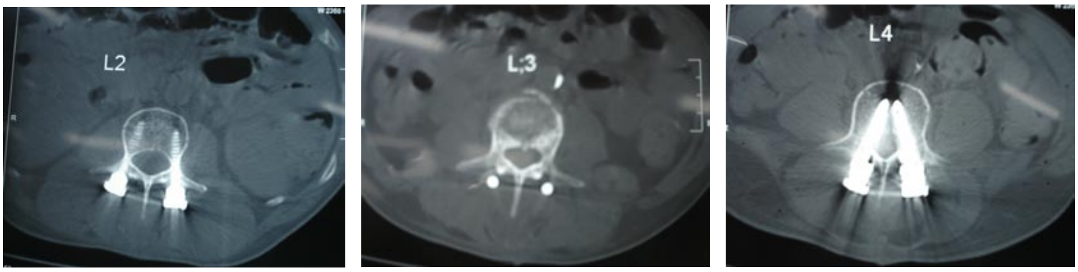
CASE 5



PRE OPERATIVE X RAY SHOWS ANTERIOR WEDGE COMPRESSION # L3

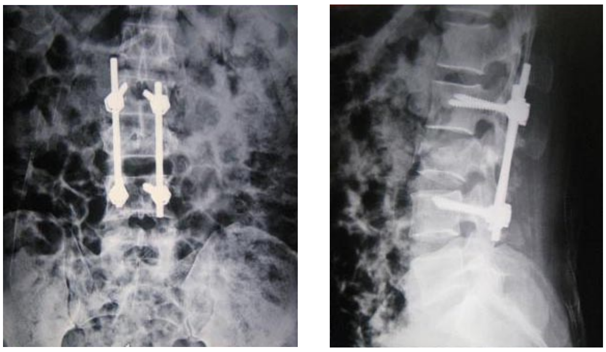


IMMEDIATE POST OPERATIVE PICTURE



POST OPERATIVE CT SCAN SHOWS CORRECT PLACEMENT OF PEDICLE SCREWS

SURGICAL SCAR



AT 6 WEEKS POST OP FOLLOW UP

AT 3 MONTHS POST OPERATIVE FOLLOW UP

DISCUSSION

Dorsolumbar spinal injury with neurological deficit is an overwhelming crisis leading to considerable morbidity and mortality. Debate exists over the exact modality of treatment and timing of intervention [46] – Whether to use

1. Anterior decompression and fusion - Anterior instrumentation
2. Posterior decompression and fusion - Posterior instrumentation
3. Combined
4. Early or late surgical intervention is helpful.

All aspects of management aims at preventing secondary injury to the spinal cord of which mechanical compression is one of the most important reversible factor.

Non-operative care avoids anaesthetic risk and morbidity of surgery but increases the risks of prolonged recumbency and hospital stay. The current surgical management corrects the deformity, enhances the neurological recovery, and allows early mobilization and return to work, with minimal complication [47,48].

With improved investigations and advanced stabilization systems and intra operative monitoring of cord function the outlook for patients with thoracolumbar fractures with neurological deficits has improved and can be enhanced if an optimum environment for neurological recovery is provided [49].

The primary management of patients with these injuries is decompression and stabilization. In our study all the cases underwent posterior decompression, short segment stabilization with pedicle screws and fusion. This was performed within 3 weeks of injury with an average of 14 days. From our study it was found that males in the age group of 20 -40 years more commonly sustain spinal injuries .

They form a most important socioeconomic group [50].The most common mode of violence is an accidental fall from height, while vehicular accidents account for a few. When compared with primitive system like the ones which force the lamina apart or straighten the spine, the pedicle screw systems with large fixation screws implanted through the pedicle into the vertebral body are better systems biomechanically .They are the only device which allows three column fixation of the vertebral column and in areas where the lamina have been removed. They provide excellent stability in fracture spine.

A short segment fixation with pedicle screw achieves reasonable stability till the segment is fused. This is so because a pedicle screw achieves a three column fixation and proper stability than the other posterior systems that were used previously. The main advantage of short segment posterior instrumentation is that it preserves the motion segment resulting in less spinal stiffness and also avoiding flat back syndrome. [51, 52].

McLain et al and McCormack et al reported that the use of short-segment posterior spinal instrumentation without restoration of the anterior column for the treatment of unstable thoracolumbar burst fractures has been associated with a high rate of early implant failure and progressive deformity[53,54,55].

Short-segment pedicle screw fixation allows for spinal stabilization while simultaneously preserving as many motion segments as possible [56-59]. When short-segment fixation was compared to long-segment fixation, the radiographic parameters were more favorable in the latter but the clinical outcome was the same for both methods [60, 61].

In our study all the cases underwent only posterior decompression, posterior stabilization and posterolateral fusion. We had not done anterior procedures. Still they had good neurological recovery. The midline spinal fusion technique performed earlier was biomechanically disadvantageous because the graft being situated far from the center of rotation experiencing tensile forces when the spine is flexed, can induce excessive motion causing the graft to migrate before it can incorporate and consolidate. This caused higher rate of pseudoarthrosis. The most commonly employed method of fusion, the posterolateral technique addresses many of these flaws. It involves fusion of the transverse processes and the facet joints of adjacent vertebrae. It allows the graft to be placed in closer proximity to the center of vertebral rotation than the midline fusion, thereby decreasing the tensile loads and graft migration. Both these factors increase the chances of obtaining a solid fusion. In our study the implant related failure and deformity were reduced because of the addition of posterolateral fusion along with short segment pedicle screw system. Fusion was done with the bone graft taken from the decorticated lamina and spinous processes and hence additional separate donor site morbidity was avoided [62,63].

The maximum follow up in our study is 15 months. During their follow up we had not seen cases with implant related failure or with worsened neurological status and deformity. Patients whose MRI showing features of cord contusion had poor recovery.

Rex A.W. Marco et al reported that the neurological function improved by at least one Frankel grade in 83% of the patients with complete neurological deficit in his study.

But in our study 73 % improvement in neurological function by one Frankel grade was observed in patients with complete neurological deficit.

The most important factor responsible for prognosis and neurological recovery is the neurological status at the time of injury. Surgical decompression and stabilization with fusion improves the neurological recovery especially in incomplete cord lesions. Out of 15 cases, 8 cases with incomplete lesions have recovered well when compared to complete lesions in our study.

In a study by Helton et al, Denis pain scale showed 44 % patients had no pain and 17 % had moderate pain to severe pain two years after surgery. While in our study 40% patients had minimal pain, 40 % patient had moderate pain and 20 % had moderate to severe pain with significant changes in daily activities.

In our study, Denis work assessment scale showed that, 33.33 % patients had unable to returned to the previous job but can able to work full time with job modification, 26.67 % patients cannot able to work full time and 40 % patients were completely disabled.

We had one case of malplacement of screw in our study which was revised later, two cases of dural tear which were repaired intraoperatively. We did not have wrong level or worsening of neurological status after surgery. There were no non contiguous or missed lesions in our study. All the associated fractures were treated by non operative methods.

CONCLUSION

Early surgery had better outcome and rehabilitation. A short segment fixation with pedicle screw along with the orthotic appliances for a considerable period of time reduces the chances of implant failure and prevents further collapse of the injured vertebra and achieves a reasonable stability till the segment is fused.

Short segment posterior instrumentation preserves the motion segment, improves functional outcome and rehabilitate the patients with minimal surgical morbidity.

The enthusiasm of fixing and fusing the unstable spine is well rewarded with reduced fracture pain, making the patient to sit up and avoiding the complications of recumbency like pressure sore, urinary infections, deep vein thrombosis, pneumonitis and aids in neurological recovery especially in partial neurological deficit patients. Though we did have a few complications they did not prevent those patients from experiencing the above advantage.

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I. CONSENT PROFORMA

Title: **EFFECTIVENESS OF POSTERIOR DECOMPRESSION AND SHORT SEGMENT INSTRUMENTED [PEDICLE SCREW] FUSION IN THORACOLUMBAR FRACTURES - A PROSPECTIVE STUDY**.

Aim: To evaluate the neurological recovery of unstable thoracolumbar fractures treated by decompression, short segment posterior stabilization with pedicle screw and fusion.

Consent: I have been explained about the nature of injury, the method of treatment, potential complications, the outcomes of not undergoing the surgery, and need of regular follow up visits in my own vernacular language

I hereby give my consent for this study.

Signature

II. CLINICAL PROFORMA

Name: Age/ Sex: IP No:

Address: Unit : Ward :

Date of Admission:

Date of Surgery:

Date of Discharge:

Diagnosis:

Associated Injuries:

Pre operative Frankel grade:

Investigations:

1. Radiograph 2.CT/MRI

3. Blood investigations 4.Chest X-Ray

5. ECG 6. Others

Operative Procedure :

Rehablitation :

Post operative Frankel grade :

Post op advice:

Follow up:
6 weeks 3rd month 4th month

Denis Pain assessment scale

Denis work assessment scale

Complications:

III. MASTER CHART

No	Name	Age/ Sex	IP NO	Mode of injury	Pre op Frankel Grade	Bladder Involvement	Bony level	PLL status in MRI	Steroids	Lag Period	Post op Frankel grade at 6 weeks of surgery	Denis pain and work status assessment scale		Complication
												pain	work	
1	Case A	22/m	1030376	Fall	B	Yes→ ®	Burst # L2	Disrupted	No	10 days	D	P3	W3	Paralytic ileus
2	Case B	30/m	1034546	Fall	B	Yes→ ®	Burst # L2	Disrupted	No	14 days	D	P2	W3	Urinary tract infection
3	Case C	45/m	1036405	RTA	C	Yes→ ®	Burst # L2	Disrupted	No	12 days	D	P2	W4	Paralytic ileus
4	Case D	59/f	1039969	RTA	A	Yes→ NR	# Dislocation L3	Disrupted	No	13 days	A	P4	W5	Death
5	Case E	40/m	1040047	Fall	A	Yes→ NR	# Dislocation L1	Disrupted	No	20 days	A	P4	W5	Dural tear
6	Case F	40/m	1042722	Fall	A	Yes→ NR	Burst # D12	Disrupted	No	18 days	C	P3	W5	Urinary tract infection
7	Case G	35/m	1050297	Fall	C	Yes→ ®	AWC # D12	Disrupted	No	16 days	D	P3	W4	Superficial wound Infection
8	Case H	30/f	1052811	Fall	C	Yes→ NR	Burst #D12	Disrupted	No	11 days	E	P2	W3	Nil
9	Case I	30/m	1053787	RTA	A	Yes→ ®	Burst # L2	Disrupted	Yes	16 days	C	P3	W5	Grade I bed sore
10	Case J	30/m	1045722	Fall	A	Yes→ NR	Burst #D11	Disrupted	No	14 days	C	P3	W5	Grade I bed sore
11	Case K	20/m	1054433	Fall	A	Yes→ NR	Burst # L2	Disrupted	Yes	19 days	D	P4	W4	Urinary tract Infection
12	Case L	37/m	1058854	Fall	D	No	AWC # L1	Intact	Yes	11 days	E	P2	W3	Nil
13	Case M	50/m	1079033	Fall	D	No	AWC # L3	Intact	No	8 days	E	P2	W3	NIL
14	Case N	17/m	1084167	Fall	C	No	Burst # L1	Disrupted	No	13 days	D	P2	W4	NIL
15	Case O	30/m	1096883	Fall	A	Yes→ NR	Burst #D11	Disrupted	No	16 days	C	P3	W5	Malplacement of pedicle screw

ABBREVIATIONS USED IN MASTER CHART

AWC # – Anterior wedge compression Fracture

Burst # -- Burst fracture

PLL – Posterior longitudinal ligament

® -- Recovered

NR – No recovery